Sept. 11, 1934.

S. B. WRIGHT ET AL

1,973,595

TWO-WAY TELEPHONE SYSTEM

Filed June 10, 1931

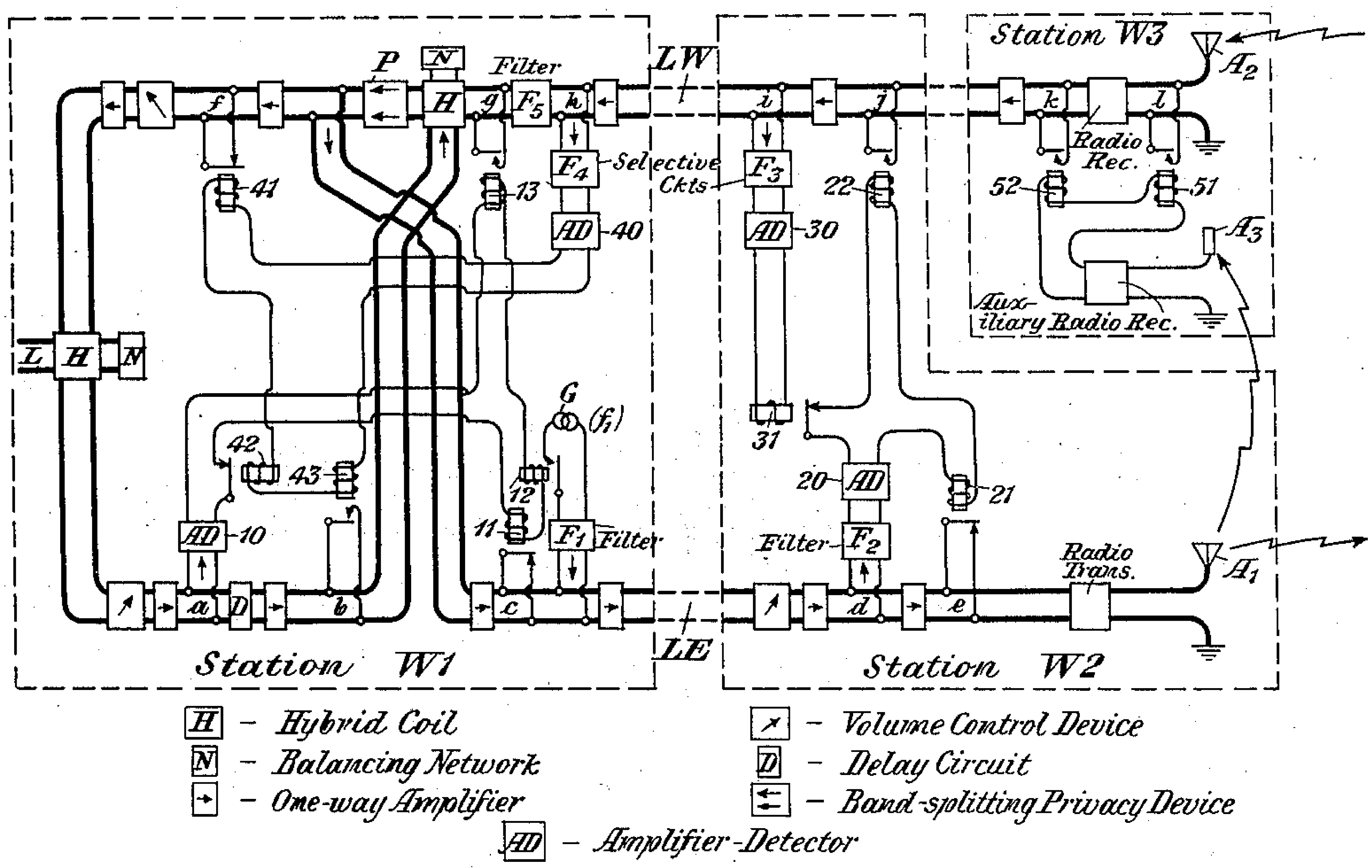

Fig. 1

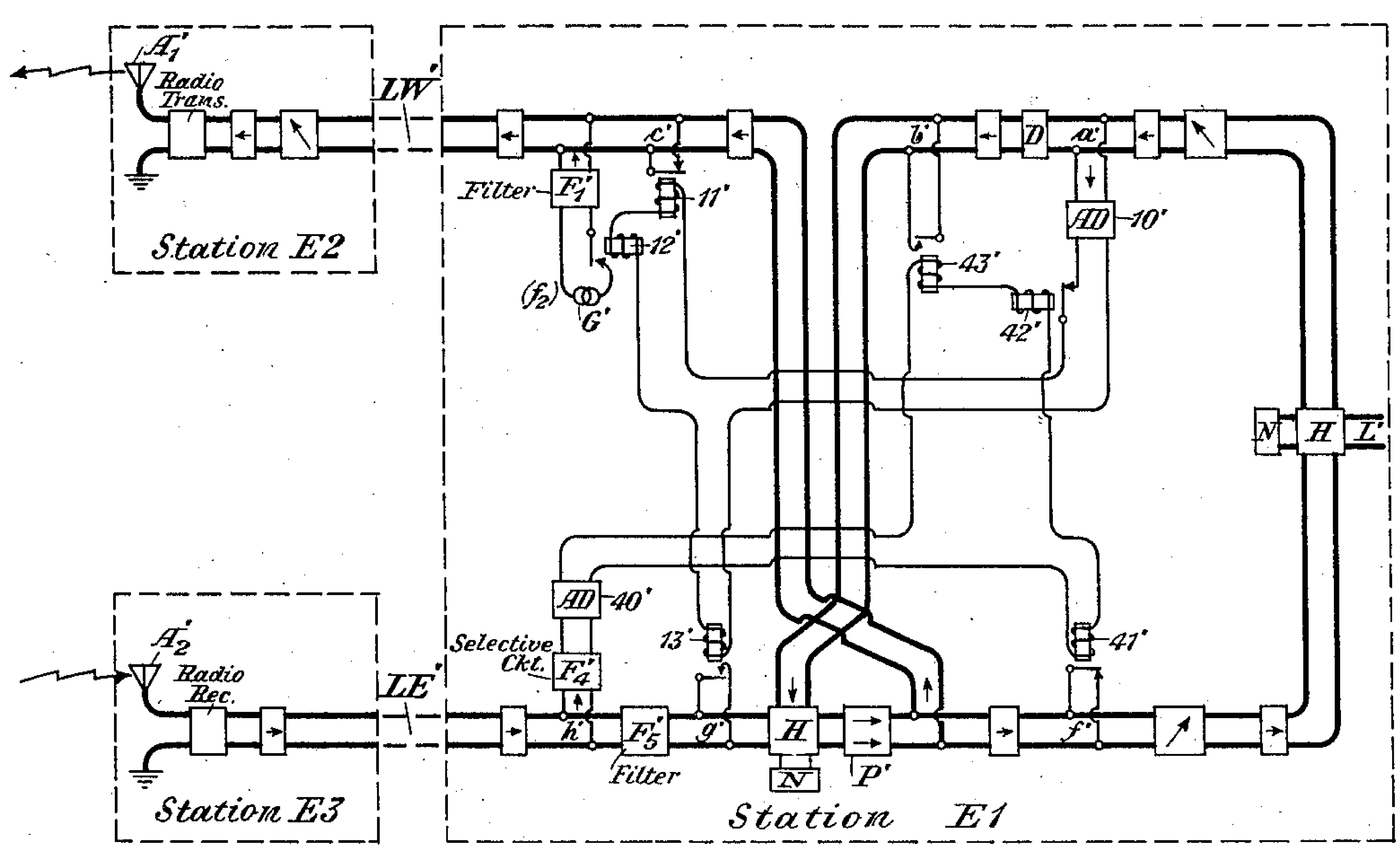

Fig. 2

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Patented Sept. 11, 1934

1,973,595

UNITED STATES PATENT OFFICE

1,973,595

TWO-WAY TELEPHONE SYSTEM

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Application June 10, 1931, Serial No. 543,446

7 Claims. (Cl. 250—9)

This invention relates to two-way systems for the transmission of electrical waves, which waves transmit over the system—or, in other words, produce at the distant end thereof—some desired over-all effect. More particularly, the invention relates to two-way telephone systems having one or more comparatively unstable or noisy links and requiring wave-responsive devices such as "singing" suppressors for controlling the transmission over the transmission paths.

In a telephone system, it is often desirable, in order to prevent "singing", to have one or both of the one way paths disabled at one or more points. It follows, of course, that means must be provided whereby the voice waves will cause the removal of any such disability normally found on the path over which these waves are to be transmitted. Thus, if the incoming or receiving path is normally disabled, it is required that the voice waves coming in from the distant end of the system cause some operation at some stage of their travel over the transmission channel which will result in rendering the receiving path operative for transmission. In addition, as is now well understood in the art, it is often desirable to have the operation caused by the transmission of voice waves extend to the actuation of echo suppressor apparatus for disabling the opposite outgoing or transmitting path, to prevent the return thereover of waves reflected from the terminal of the system.

Now the transmission system may include what will be hereinafter termed a "mutable" link—that is, a link capable of or liable to change (from internal or external cause) which may give rise to interfering energy, or, more specifically, a link specially subject to noise, fading (in the case of radio transmission) or change of impedance. For instance, if the system is composed of two wire sections and an intermediate radio link, the radio link will usually be noisy or otherwise mutable in comparison with the wire sections. The presence of this mutable link introduces complications in connection with the operation of wave-responsive devices designed to act on a transmission path on the distant or receiving side of the mutable link—for instance, on the wire section at the receiving end of a radio link. If these wave-responsive devices near the receiving end are made quite sensitive, they are liable to false operation by the noise or other interfering energy having its origin in the mutable link. On the other hand, if they are made insensitive, they may fail to operate in response to any but the strongest speech. In short, the problem presented is how to obtain positive operation of the receiving transmission control devices in response to voice waves without the serious hazard of false operation by noise energy and the like. The proper control of the received volume serves to reduce the problem, but further solution is desirable.

A promising proposed solution of the problem indicated above involves the use of "control currents". These currents are single frequency currents released on the transmitting side of the mutable link by the voice waves and transmitted thereover to the distant or receiving section of the system. In this latter section, suitable means are employed whereby the wave-responsive devices such as singing suppressors respond only to the control frequency and are thus rendered immune to such energy as noise. As a variation of this solution, the control current may be kept on the circuit when no speech is transmitted and removed under the control of the transmitted speech, the operation of the devices at the receiving end being altered accordingly. It is unnecessary to discuss at any length herein the respective advantages and disadvantages of the two forms of special frequency control, but reference may be had to two United States Patents, No. 1,674,695 to Nyquist and Wright and No. 1,675,412 to Holden, the latter being directed to the control by special frequency of echo suppressors as distinguished from singing suppressors.

In addition to the problem stated above, there are other important problems which arise in connection with long two-way transmission systems, especially in connection with those systems which are equipped with wave-responsive control devices and which comprise several links, one or more of them noisy or otherwise mutable. In long telephone systems, it is important that all feasible precautions be taken against mutual-lock-out, the condition in which both speakers cause the operation of wave-responsive devices so as to render the system inoperative for the transmission of speech in either direction. Again, it is important, when one speaker is temporarily locked out by the devices under the control of the second speaker, that the first speaker be able to break in without undue delay when the second pauses. Furthermore, it is often important that a speaker who takes control of his end of the circuit and gets through to the distant end shall be able to control the incoming path at the distant terminal even though the second speaker has started to talk while the waves from the first are being transmitted over the intervening transmission medium.

The applicants have as the principal object of their invention the provision of transmission methods and means whereby the various problems and difficulties outlined above are substantially solved or overcome. The invention is particularly applicable to a long two-way system such as the present long-wave transatlantic telephone circuit, which comprises the transoceanic radio link and connected circuits leading to the respective terminals at New York and London, as will be more fully discussed below. Accordingly, the principal specific objects which the applicants have in mind are (1) the elimination of the limitations imposed by static in the transoceanic link upon the operation of the wave-responsive devices on the receiving paths leading from that link to London and New York, (2) the reduction of the breaking time and (3) the elimination of mutual lock-out. Thus, in its broader aspect, the invention resides in methods or in combinations of means for accomplishing all of these major results. Other objects and advantages of the invention will appear upon examination of the following detailed description and discussion of the embodiment selected for the purpose of illustration, which are to be read with reference to the accompanying drawing.

It will be obvious that the invention is equally applicable to many other types of two-way systems including transmission media or links different from those specifically disclosed. For instance, the transoceanic radio link might be replaced by a submarine cable without reducing the applicability of the principles of the invention.

Figure 1 of the drawing shows schematically and in part diagrammatically the western section of the transatlantic long-wave radio system, connecting New York with two points in Maine, the western terminals of the radio circuit. Fig. 2 shows in like manner the eastern section of the system which connects the two eastern terminals of the radio circuit with London.

The station W1 is the terminal station at New York. It will be understood that the two-way system may be extended westward beyond New York in any suitable manner. The extension specifically indicated is over a two-wire line L which is connected to the eastward path LE and the westward path LW of a four-wire circuit through a hybrid coil, the line L being balanced by a network. The station W2 is at Bangor, from which point transmission over the Atlantic is by radio. The station W3 is at Houlton, at which point the radio waves are received. The path LE is a wire path extending from New York to Bangor and adapted for transmission from New York to Bangor. The wire path LW extends from Houlton through Bangor to New York and is adapted for transmission in that direction.

At the eastern end of the system shown in Fig. 2, station E1 is the terminal station at London, from which the system may be extended to European points over the one-way line L′, for instance, which line is connected to the one-way paths LW′ and LE′ of the four-wire circuit through a hybrid coil, the line L′ being balanced by a network. Station E2 is the radio transmitting station at Rugby, and the line LW′ is adapted for transmission from station E1 to station E2. Station E3 is at Cupar in Scotland. This station is the receiving terminal of the radio circuit, and the line LE′ is adapted for transmission between stations E3 and E1.

Thus the system extending from station W1 at the west end to station E1 at the east end includes a path adapted for transmission from west to east and comprising the wire section LE, the radio link between stations W2 and E3 and the wire section LE′, and another path adapted for transmission from east to west and comprising the wire section LW′, the radio link between stations E2 and W3 and the wire section LW.

It will be understood, of course, that the principal mutable link in either one of these one-way channels is the radio link. It should be borne in mind, however, that wire circuits may be mutable. The sections of paths LE and LW lying between stations W1 and W2 are between 400 and 500 miles in length, and the wire connection between stations W2 and W3 is between 100 and 200 miles in length. At the eastern end of the system, the wire circuit from station E1 to station E2 is less than 100 miles long, but the circuit from station E3 to station E1 is between 400 and 500 miles in length. These figures are cited chiefly to indicate the variety of transmission media which may be involved in the solution of the problems with which the applicants are dealing.

It is proposed, first, to describe, in general, at least, the circuit elements which make up the system between the terminals of the four-wire circuit at stations W1 and E1, respectively, it being understood that in many instances these elements do not, in themselves, form any part of the applicants' invention. A proper understanding of a system such as that specifically disclosed is essential, however, to the understanding of the invention.

Voice waves passing in the line L divide at the hybrid coil, and the effective portion of the energy passes over the line LE through a volume regulator and the one-way amplifier. At the point a, a portion of the energy operates an amplifier-detector 10, which may control relays 11, 12 and 13. The main portion of the energy passes through a delay circuit and another one-way amplifier, through a hybrid coil and a band-splitting device P and through other one-way amplifiers to the station W2. The device P may be any suitable device for "scrambling" the speech currents in order to get a degree of secrecy. The principles upon which such a device operates are disclosed in United States Patent No. 1,546,439 to Espenschied, for example. It will be understood that the operation of this device involves the proper control of contacts at point g in path LW and point c in path LE, as will be more fully discussed hereinbelow. It should be noted that beyond the point c in path LE, provision is made for the application to that path of a current of special frequency f_1, which is the eastward control frequency. It will be noted further that the point at which this control current is applied is near the west terminal of the four-wire circuit, hundreds of miles from the radio terminal at station W2.

Upon reaching station W2, the voice waves in path LE pass through another volume regulator and other one-way amplifiers to the radio transmitter and are then radiated from the transmitting antenna A_1. As will be fully described hereinbelow, the transmission path which is normally disabled at the point e is rendered operative for the transmission of the voice waves by certain operations under the control of the special frequency current.

At the European end of the system, the waves from the antenna A_1 at station W2 are received at station E3 by the antenna A'_2, are passed through the radio receiver and a one-way amplifier and are then transmitted to station E1, the terminal station. At that station, the voice waves pass through other one-way amplifiers and a volume regulator. They also pass through a hybrid coil and a band-splitting privacy device P' which serves to "unscramble" the voice currents, producing intelligibility. It will be noted that the path LE' at station E1 is normally disabled at the point f'. This disability is removed, as willl be more fully discussed hereinbelow, under the control of the special control current transmitted from the American terminal of the system. For this purpose, the control energy is diverted from the path LE' at point h' to operate the amplifier-detector 40', which, in turn, causes the operation of relay 41' and also the operation of relays 42' and 43'. The waves finally pass through the hybrid coil at the eastern terminal of the four-wire circuit, the effective portion being transmitted over the extending two-wire line L'.

The waves passing from east to west are transmitted through the hybrid coil and the usual one-way amplifiers and volume regulators in the path LW'. A portion of the energy is diverted to operate amplifier-detector 10', which controls relays 11', 12' and 13'. The privacy arrangement is the same as that indicated in connection with transmission from west to east, the contacts at points g' and c' corresponding to the contacts at the west end. The control current is applied beyond the point c' and is transmitted to the American end of the system. This control current is a current of special frequency f_2. The voice waves which pass the point c' are transmitted to station E_2 and through the radio transmitter and are radiated from the antenna A'_1.

At station W3, the east-west waves are received in the antenna A_2 and the radio receiver in path LW and are transmitted over the portion of the receiving channel at station W2. There certain switching operations are performed under the control of the east-west control current, as will be more fully discussed hereinbelow. The east-west waves are then transmitted on to station W1, where the control current operates amplifier-detector 40 and relays 41, 42 and 43. The waves pass through the usual one-way amplifiers and the volume regulator and also through the hybrid coil and privacy device P, which "unscrambles" the voice currents. It should be noted that the east-west path LW at station W_1 is normally disabled at point f and that this disability is removed by the operation of amplifier-detector 40. At the west terminal of the four-wire circuit the waves pass through the hybrid coil and on over the two-wire line L.

It should be noted, in connection with a description of various circuit elements making up the system, that at station E1 between points h' and g' is a filter F'_5. This element is a device for suppressing the control frequency f_1. Similarly, in the path LW at station W1, between the points h and g, there is included a filter F_5 which serves to suppress the control frequency f_2.

It should be noted further that at station W3, there is indicated an auxiliary receiving antenna A_3, which may be the back end of the antenna A_2, and an auxiliary radio receiver. In the output of this auxiliary receiver are the relays 51 and 52, which control contacts operating on the path LW at points l and k. The operation of this arrangement will be disclosed hereinbelow.

It will be noted that no auxiliary switching devices are shown at the European radio terminals, stations E2 and E3. From this disclosure, it will be understood that different conditions demand different arrangements at various points on a two-way system such as that disclosed, and that the applicants' invention is quite independent of many of the details which it is deemed desirable to include in the disclosure of the long-wave radio telephone system.

It remains to take up in some detail the arrangement and operation of the various circuit elements with particular regard to the applicants' transmission control forming the principal subject matter of the invention. It should be borne in mind that each one-way path at each end of the system is normally disabled near the terminal, i. e. at station W1 or at station E1. Path LE is normally disabled at point c, path LW at point f, path LW' at point c' and path LE' at point f'. In addition, path LE is normally disabled at station W2 at point e for a purpose to be discussed hereinbelow.

When voice waves from line L pass over the one-way path LE, there are two points in the system at which contacts must be operated to insure the travel of the waves over the first stage. An examination of Fig. 1 will show that the circuit arrangements connected with the privacy device P are such that the circuit is prepared at this point for the transmission of waves from east to west in the path LW, the contact at point c in path LE being closed to disable the path and the contact at point g in path LW being open to render that path operative; in addition path LW is disabled at point f. This arrangement, of course, prevents singing. Therefore, it is necessary for proper transmission from west to east that switching operations be performed in response to the voice waves in path LE which will adapt the privacy arrangement to pass and to scramble the east-bound voice currents and which will insure free passage of the voice waves toward station W2. This set of operations is performed by the relays controlled by amplifier-detector 10, into which, it has been seen, a portion of the east-bound voice energy is diverted at point a. Upon the operation of amplifier-detector 10, relays 11, 12 and 13 are operated. Relay 11 removes the disability from path LE at point c, and relay 13 disables the path LW at point g. Accordingly, the voice waves will pass through the hybrid coil and the device P and pass on through point c toward staton W2. It has been noted that beyond point c an alternating current generator G is associated with the path LE. When relay 12 operates, this generator is connected to the path LE through a filter F_1, which reduces the effect of transient currents set up by the application of the generator. Thus, the control wave of the frequency f_1 is sent over path LE somewhat ahead of the voice waves, which, in the circuit under discussion, are delayed by the delay circuit between points a and b and by their passage through the privacy device P. At station W2, it is desirable that the path LE be normally disabled at point e and that provision be made for the disabling of path LW at point j, to prevent the undesirable effects of radio coupling between the transmitting antenna

A_1 and the receiving antenna A_2 at station W_3. This hazard of radio coupling is, of course, greater as the two radio stations are located closer to each other. Accordingly, it becomes necessary to cause some operation which will clear the path LE at point *e*. This operation the applicants control by the control current f_1, thus preventing false operation by any noise currents or the like originating in path LE due to the mutability of the link connecting stations W1 and W2. At the point *d*, the amplifier-detector 20 is connected through a filter F_2, which serves to pass the control frequency f_1 and substantially to exclude other frequencies. In response, then, to the control wave, which, it has been seen, somewhat precedes the voice energy, the amplifier-detector operates and causes the operation of relays 21 and 22. Relay 21 removes the disability from path LE at point *e*, and relay 22 disables the path LW at point *j*.

In the system specifically disclosed, further measures are taken against the hazard of radio coupling. At station W3 an auxiliary radio receiver is connected to the back end A_3 of the receiving antenna, which serves to pick up part of the control energy radiated from the antenna A_1. It will be understood that, by well known methods of directional selectivity, this auxiliary receiver can be made to respond to the control energy from A_1 and be unresponsive to energy coming into station W3 from Europe. The auxiliary receiver controls the operation of relays 51 and 52. These relays, upon operation, disable the receiving path LW at points *l* and *k*. Thus, the waves transmitted from station W2 are prevented from entering and overloading the radio receiver at station W3 and from affecting the receiving path LW. Further protection against false transmission in the path LW is provided by the operation discussed hereinabove of relay 22 at station W2.

At the European end of the west-east channel, the radio waves transmitted from station W2 are picked up by the receiving antenna A'_2 and impressed upon the radio receiver. The waves then travel to the terminal station E1. At the point *h'*, on transmission path LE', an amplifier-detector 40' is connected through a selective circuit F'_4, which renders the amplifier-detector responsive only to the control frequency f_1. When this amplifier 40' is operated by the control current, relays 41', 42' and 43' are operated. Relay 41' removes the normal disability at *f'* and allows the passage of the voice waves, which have been unscrambled in the privacy device P'. Relay 43' disables the opposite path LW' at *b'*, preventing echoes. Relay 42' serves to prevent the operation of relays 11' and 13' in response to the operation by outgoing voice waves of amplifier-detector 10'; if these relays 11' and 13' have already been operated, the operation of relay 42' terminates their operation and transfers from the London speaker to the New York speaker the control of the eastern terminal of the system. Thus, if the voice waves from New York line L have passed control points at station W1 and are transmitted through to station E1, they can reach the terminal at station E1 even though the speaker connected to line L' has in the meantime begun to talk and through the operation of amplifier-detector 10' has taken temporary control of the near end of the outgoing path LW'.

As has been indicated hereinabove, the control current of frequency f_1 is prevented from reaching the subscriber connected to line L' since it is blocked by the filter or other device F'_5, which is, of course, tuned to eliminate the frequency f_1.

The operation of the system in connection with transmission from east to west is similar to that in connection with the opposite transmission. The voice waves from line L' operate amplifier-detector 10', and, if control of this portion of the system has not been taken away from the near speaker by the incoming control current, relays 11', 12' and 13' are operated. Relays 11' and 13' switch the privacy device P', provision thus being made for the scrambling of the outgoing voice waves, and the path LW' is cleared for transmission. The operation of relay 12' applies to the path LW' the east-west control current of frequency f_2 from the generator G' through the filter F'_1. Due to the delays introduced by the delay circuit inserted between points *a'* and *b'* and by the privacy device P', this control current somewhat precedes the voice waves and is transmitted to station E2, where the radio transmitter and the antenna A'_1 serve to transmit the waves to the American station W3. There the waves are picked up by the antenna A_2, and the radio receiver operates, unless, of course, the auxiliary apparatus has operated to disable the path LW. Passing over the connecting link to station W2, the incoming control currents are passed through the selective circuit F_3 and operate amplifier-detector 30. The relay 31 controlled by the amplifier-detector is then operated and serves to take control of the system at this point against later arriving waves from New York by preventing the operation of relays 21 and 22. In other words, this east-west control current serves to maintain the transmitting path LE in disabled condition even though voice waves are traveling in the opposite direction between stations W1 and W2. This feature eliminates mutual lock-out since, for instance, if the west-bound energy reaches this point, control of the incoming path is held regardless of the later arriving energy traveling in the opposite outgoing path.

The control wave then passes on to station W1 and operates amplifier-detector 40, which is connected to the path LW at point *h* through the selective circuit F_4, tuned to pass only the control frequency. Relays 41, 42 and 43 now operate. The operation of relays 41 and 43 serves to remove the normal disability from the path LW at point *f* and to disable the path LE at point *b*. The operation of relay 42 prevents the operation of relays 11 and 13 in response to voice waves from line L or, if these relays have already been operated, they are promptly released in response to the operation of relay 42. Thus, as has been seen in connection with the opposite end of the system, the westward-bound energy reaching station W1 assures control of the circuit even though the New York speaker has begun to talk. When relay 41 operates, removing the disability from path LW at point *f*, this path is cleared for the passage of the voice waves, which now travel freely to the listener connected to line L.

It will now be understood that, by virtue of the applicants' arrangements, the normally disabled receiving path at either end of the system is rendered operative for the transmission of voice waves in a positive manner by an operation produced exclusively by the control current, which, in turn, is applied at the distant end of the system by the outgoing voice waves; thus, the singing suppressor contacts operate positively to render the receiving path open to voice waves but are substantially free from false operation by noise energy or the like having its origin in a mutable intermediate link.

The control wave, it will be understood by those skilled in the art, in addition to being confined to a narrow frequency band and thus easy to detect in spite of interfering noise energy, is applied suddenly with full amplitude and is thus advantageous over voice waves for the production of the prompt and positive operation of the transmission controlling relays.

It will be noted, further, that in their travel over the system the unassisted voice waves are required to operate only one set of relays—those controlled by the amplifier-detector 10 (or 10'); as the waves pass on over the system, all subsequent operations are accomplished by the control energy. Accordingly, there is no additional opportunity for clipping of the voice waves after the first operation, even though relays must be operated at several successive points to permit the passage of the voice waves.

Again, by virtue of the applicants' arrangements, the waves which pass over the system to the distant end are given positive control of the incoming channel at that end, even though the waves passing in the other direction have already entered the outgoing path; thus the breaking time is reduced to the minimum.

Furthermore, it will be noted that the chances of mutual lock-out is eliminated, since the subscriber who first takes control of relays 21 and 22 at station W2 will be heard by the subscriber connected to the other end of the system.

In addition, there is provided at one terminal of the radio link satisfactory prevention of radio coupling. It is, of course, feasible to provide this feature at both ends of the radio link, if such an arrangement is desirable.

While the invention has been disclosed in detail in our specific embodiment, it is to be understood that such disclosure is merely for the purpose of illustration and that the invention may be embodied in many other and widely different forms within the scope of the appended claims.

What is claimed is:

1. In a two-way system for the transmission of electrical waves, including a terminal station, a radio transmitting station, a radio receiving station, a transmitting path connecting said terminal station and said transmitting station and a receiving path connecting said receiving station and said terminal station, the method of transmission control which consists in causing the waves in said transmitting path at the terminal station to apply special control energy to said path for transmission to the transmitting station, radiating said control energy from the transmitting station, causing a portion of the radiated control energy to be received at the receiving station, and causing the received control energy to disable the receiving path at the receiving station for any wave transmission.

2. In a two-way system for the transmission of electrical waves, a terminal station, a radio transmitting station, a radio receiving station, a transmitting path connecting said terminal station and said transmitting station, a receiving path connecting said receiving station and said terminal station, means at said terminal station responsive to the waves transmitted to produce the desired over-all effect for controlling the transmission over said transmitting and receiving paths thereat and for applying special control energy to said transmitting path, and means responsive to said control energy for preventing radio coupling between said transmitting and receiving stations.

3. In a two-way system for the transmission of electrical waves, including a radio link, two terminal stations each distant from one end of said radio link, a transmitting connection and a receiving connection from each end of said radio link to the corresponding terminal station, means associated with the terminal end of one of said transmitting connections and responsive to the waves transmitted thereover for applying control energy to said connection, means associated with the terminal end of the distant receiving connection and responsive substantially only to said control energy for controlling the transmission over said receiving connection and the opposite transmitting connection, and means responsive to the control energy applied to said transmitting connection for preventing radio coupling between the radio end of said transmitting connection and the radio end of the opposite receiving connection.

4. In a two-way system for the transmission of electrical waves, including a radio link, two terminal stations each distant from one end of said radio link, a transmitting connection and a receiving connection from each end of said radio link to the corresponding terminal station, means associated with the terminal end of one of said transmitting connections and responsive to the waves transmitted thereover for applying control energy to said connection, means associated with the radio end of said transmitting connection and responsive substantially only to said control energy for controlling the transmission over said transmitting connection and the opposite receiving connection, means responsive to the control energy applied to said transmitting connection for preventing radio coupling between the radio end of said transmitting connection and the radio end of the opposite receiving connection, and means associated with the terminal end of the distant receiving connection and responsive substantially only to said control energy for controlling the transmission over said receiving connection and the opposite transmitting connection.

5. In a two-way system for the transmission of electrical waves, including two paths adapted for transmission in opposite directions, a radio link forming an intermediate portion of each of said paths, two terminal stations each distant from one end of said radio link and a transmitting connection and a receiving connection from each end of said radio link to the corresponding terminal station, the method of transmission control which consists in causing the waves transmitted over the terminal end of one of said transmitting connections to apply control energy to said transmitting connection, radiating said control energy from the radio end of said transmitting connection, causing a portion of the radiated control energy to be received at the radio end of the opposite receiving section at the same end of the radio link, causing the control energy so received to disable the radio end of said receiving connection for any wave transmission, and causing the control energy reaching the terminal end of the distant receiving connection on the other side of the radio link to control the transmission over said distant receiving connection and the opposite transmitting connection.

6. In a two-way system for the transmission of electrical waves, including two paths adapted for transmission in opposite directions, a radio link forming an intermediate part of each of said paths, two terminal stations each distant from one end of said radio link and a transmitting con-

nection and a receiving connection from each end of said radio link to the corresponding terminal station, the method of transmission control which consists in causing the waves transmitted over the terminal end of one of said transmitting connections to control the transmission over said connection and the opposite receiving connection and to apply control energy to said transmitting connection, radiating said control energy from the radio end of said transmitting connection, causing a portion of the radiated control energy to be received at the radio end of the opposite receiving connection at the same end of the radio link, causing the control energy so received to disable the opposite receiving connection at said end of the radio link for any wave transmission, and causing the control energy reaching the terminal end of the distant receiving connection to control the transmission over said distant receiving connection and the opposite transmitting connection.

7. In a two-way system for the transmission of electrical waves including two paths adapted for transmission in opposite directions, a radio link forming an intermediate portion of each of said paths, two terminal stations each distant from one end of said radio link and a transmitting connection and a receiving connection from each end of said radio link to a corresponding terminal station, the method of transmission control which consists in causing the waves transmitted over the terminal end of either transmitting connection to control the transmission efficiency of the near ends of the paths and to apply control energy to the near transmitting connection, radiating the control energy applied to one of said transmitting connections from the radio end of said transmitting connection, causing a portion of the radiated control energy to be received at the radio end of the opposite receiving connection at the same end of the radio link, causing the control energy so received to disable the radio end of said receiving connection for any wave transmission, causing the control energy received at the terminal end of either receiving connection to control the transmission over the near ends of the paths, and causing the control energy received at the terminal end of one of said receiving connections from the distant end of the radio link to render the near ends of the paths exempt from transmission control by energy in the near transmitting connection.

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